WHAT IS CLAIMED IS:

1. A motion video encoding device which adaptively selects and uses intra-frame encoding or inter-frame prediction encoding for encoding each block as an encoding unit, comprising:

frame memory means for storing an input image and a reference image as the result of decoding of a frame before;

block encoding means for referring to the input image stored in the frame memory means and carrying out a block encoding process for each block of the input image according to a selected encoding mode and a quantization step designating the width of quantization of image data and thereby generating coded data;

code counting means for monitoring the coded data and thereby counting the code volume from the latest synchronization code pattern inserted in the coded data to coded data of a block that has been encoded latest;

code volume control means for referring to the code volume of the coded data outputted by the block encoding means and a pixel value distribution statistic obtained by analyzing the input image and the reference image stored in the frame memory means, thereby calculating the quantization step for each block and for each selectable encoding mode so that image distortion caused by the block encoding process will be minimum, and outputting a code volume predicted value assigned to a target block which will be encoded next, under the condition that the code volume for a frame should be a preset volume or less;

data loss probability estimation means for estimating the probability that data loss will occur to the target block due to transmission error, based on the code volume predicted value assigned to the target block, the code volume counted by the code counting means, and a preset error probability per bit;

frame coding distortion estimation means for estimating frame

coding distortion as image distortion caused by the block encoding processes for the frame, by referring to the pixel value distribution statistic of the input image obtained by the code volume control means;

degradation power calculation means for calculating degradation power as error power between the input image and a decoded image assuming that data loss occurred to the target block during data transmission of the coded data, by use of the input image or the reference image stored in the frame memory means;

degradation estimation calculation means for calculating a degradation estimation as an expected value of image degradation occurring to the target block due to data loss caused by transmission error, for each block and for each selectable encoding mode, based on the degradation power calculated by the degradation power calculation means and the data loss probability estimated by the data loss probability estimation means; and

mode selection means for selecting an optimum encoding mode for the target block by referring to the degradation estimation calculated by the degradation estimation calculation means and the frame coding distortion estimated by the frame coding distortion estimation means.

2. A motion video encoding device as claimed in claim 1, wherein the degradation power calculation means complements pixel values of the target block with pixel values of surrounding pixels of the input image, and regards error power between the complemented image and the input image as the degradation power.

3. A motion video encoding device as claimed in claim 1, wherein the degradation power calculation means complements pixel values of the target block with pixel values of a block of the reference image at the same position as the target block, and regards error power

between the complemented image and the input image as the degradation power.

4. A motion video encoding device as claimed in claim 1, wherein the degradation power calculation means complements pixel values of the target block by copying pixel values from a motion compensation area of the reference image corresponding to the target block, and regards error power between the complemented image and the input image as the degradation power.

5. A motion video encoding device as claimed in claim 1, wherein the data loss probability estimation means estimates the probability that data loss will occur to the target block due to transmission error, by adding the code volume predicted value assigned to the target block by the code volume control means to the code volume counted by the code counting means and multiplying the sum by the preset error probability per bit.

6. A motion video encoding device as claimed in claim 1, wherein the degradation estimation calculation means obtains the degradation estimation in the case of the intra-frame encoding by multiplying the degradation power calculated by the degradation power calculation means by the data loss probability estimated by the data loss probability estimation means, and

obtains the degradation estimation in the case of the inter-frame prediction encoding by obtaining the product of the degradation power and the data loss probability, obtaining a degradation propagation term as a degradation estimation of a referred area of the reference image which is referred to for a motion compensation process in the inter-frame prediction encoding, and adding the degradation propagation term to the

product.

7. A motion video encoding device as claimed in claim 1, wherein the degradation estimation calculation means obtains the degradation estimation in the case of the intra-frame encoding by multiplying the degradation power calculated by the degradation power calculation means by the data loss probability estimated by the data loss probability estimation means, and

obtains the degradation estimation in the case of the inter-frame prediction encoding by obtaining the product of the degradation power and the data loss probability, obtaining a degradation propagation term as a weighted average of degradation estimations of blocks overlapping with a referred area of the reference image which is referred to for a motion compensation process in the inter-frame prediction encoding, and adding the degradation propagation term to the product.

8. A motion video encoding device as claimed in claim 1, wherein the degradation estimation calculation means obtains the degradation estimation in the case of the intra-frame encoding by multiplying the degradation power calculated by the degradation power calculation means by the data loss probability estimated by the data loss probability estimation means, and

obtains the degradation estimation in the case of the inter-frame prediction encoding by obtaining the product of the degradation power and the data loss probability, obtaining a degradation propagation term as a degradation estimation of a referred area of the reference image which is referred to for a motion compensation process in the inter-frame prediction encoding, multiplying the degradation propagation term by a proportionality constant, and adding the multiplied degradation propagation term to the product.

9. A motion video encoding device as claimed in claim 1, wherein the mode selection means obtains the degradation estimation of the target block in each candidate encoding mode from the degradation estimation calculation means, obtains the frame coding distortion in each candidate encoding mode from the frame coding distortion estimation means, and selects a candidate encoding mode that minimizes the sum of the degradation estimation and the frame coding distortion as the optimum encoding mode for the target block.

10. A motion video encoding device as claimed in claim 1, wherein:

the motion video encoding device further comprises block coding distortion estimation means for estimating block coding distortion as image distortion caused by the block encoding process for the target block by referring to the input image and the reference image stored in the frame memory means and the quantization step calculated by the code volume control means, and

the mode selection means selects an optimum encoding mode for the target block from the intra-frame encoding, the inter-frame prediction encoding and another encoding mode "skip" in which pixel values are directly copied from a block of the reference image at the same position as the target block, by referring to the degradation estimation calculated by the degradation estimation calculation means, the frame coding distortion estimated by the frame coding distortion estimation means and the block coding distortion estimated by the block coding distortion estimation means, and

the degradation estimation calculation means calculates the degradation estimation as an expected value of image degradation occurring to the target block due to data loss caused by transmission

error, for each block and for each of the selectable encoding modes: the intra-frame encoding; the inter-frame prediction encoding; and the skip, based on the degradation power calculated by the degradation power calculation means and the data loss probability estimated by the data loss probability estimation means.

11. A motion video encoding device as claimed in claim 10, wherein:

the block coding distortion estimation means estimates the block coding distortion of the target block in the case of the intra-frame encoding or the inter-frame prediction encoding, as quantization distortion by use of the quantization step calculated by the code volume control means, and

the block coding distortion estimation means estimates the block coding distortion of the target block in the case of the skip, by obtaining error power between the target block and a block of the reference image at the same position as the target block and regarding the error power as the block coding distortion, and

the data loss probability estimation means estimates the data loss probability of the target block in the case of the intra-frame encoding or the inter-frame prediction encoding, based on the code volume predicted value assigned to the target block, the code volume counted by the code counting means, and a preset error probability per bit, and

the data loss probability estimation means estimates the data loss probability of the target block in the case of the skip, based on the code volume of a skip code which indicates that the encoding mode is the skip, the code volume counted by the code counting means, and a preset error probability per bit, and

the degradation estimation calculation means calculates the degradation estimation of the target block in the case of the skip, in the

same way as the case of the inter-frame prediction encoding.

12. A motion video encoding device as claimed in claim 10, wherein the mode selection means obtains the degradation estimation of the target block in each of the intra-frame encoding and the inter-frame prediction encoding from the degradation estimation calculation means,

obtains the frame coding distortion in each of the intra-frame encoding and the inter-frame prediction encoding from the frame coding distortion estimation means,

selects an encoding mode that minimizes the sum of the degradation estimation and the frame coding distortion from the intra-frame encoding and the inter-frame prediction encoding as a candidate optimum encoding mode for the target block,

compares the selected candidate optimum encoding mode with the skip by making a comparison between the two encoding modes with regard to the sum of the degradation estimation calculated by the degradation estimation calculation means and the block coding distortion estimated by the block coding distortion estimation means, and

selects one of the two encoding modes that minimizes the sum as the optimum encoding mode for the target block.

13. A motion video encoding method which adaptively selects and uses intra-frame encoding or inter-frame prediction encoding for encoding each block as an encoding unit, comprising the steps of:

an image storage step for storing an input image and a reference image as the result of decoding of a frame before in a frame memory;

a block encoding step for referring to the input image stored in the frame memory and carrying out a block encoding process for each block of the input image according to a selected encoding mode and a quantization step designating the width of quantization of image data

and thereby generating coded data;

a code counting step for monitoring the coded data and thereby counting the code volume from the latest synchronization code pattern inserted in the coded data to coded data of a block that has been encoded latest;

a code volume control step for referring to the code volume of the coded data generated in the block encoding step and a pixel value distribution statistic obtained by analyzing the input image and the reference image stored in the frame memory, thereby calculating the quantization step for each block and for each selectable encoding mode so that image distortion caused by the block encoding process will be minimum, and outputting a code volume predicted value assigned to a target block which will be encoded next, under the condition that the code volume for a frame should be a preset volume or less;

a data loss probability estimation step for estimating the probability that data loss will occur to the target block due to transmission error, based on the code volume predicted value assigned to the target block, the code volume counted in the code counting step, and a preset error probability per bit;

a frame coding distortion estimation step for estimating frame coding distortion as image distortion caused by the block encoding processes for the frame, by referring to the pixel value distribution statistic of the input image obtained in the code volume control step;

a degradation power calculation step for calculating degradation power as error power between the input image and a decoded image assuming that data loss occurred to the target block during data transmission of the coded data, by use of the input image or the reference image stored in the frame memory;

a degradation estimation calculation step for calculating a degradation estimation as an expected value of image degradation

occurring to the target block due to data loss caused by transmission error, for each block and for each selectable encoding mode, based on the degradation power calculated in the degradation power calculation step and the data loss probability estimated in the data loss probability estimation step; and

a mode selection step for selecting an optimum encoding mode for the target block by referring to the degradation estimation calculated in the degradation estimation calculation step and the frame coding distortion estimated in the frame coding distortion estimation step.

14. A motion video encoding method as claimed in claim 13, wherein in the degradation power calculation step, pixel values of the target block are complemented with pixel values of surrounding pixels of the input image, and error power between the complemented image and the input image is regarded as the degradation power.

15. A motion video encoding method as claimed in claim 13, wherein in the degradation power calculation step, pixel values of the target block are complemented with pixel values of a block of the reference image at the same position as the target block, and error power between the complemented image and the input image is regarded as the degradation power.

16. A motion video encoding method as claimed in claim 13, wherein in the degradation power calculation step, pixel values of the target block are complemented by copying pixel values from a motion compensation area of the reference image corresponding to the target block, and error power between the complemented image and the input image is regarded as the degradation power.

17. A motion video encoding method as claimed in claim 13, wherein in the data loss probability estimation step, the probability that data loss will occur to the target block due to transmission error is estimated by adding the code volume predicted value assigned to the target block in the code volume control step to the code volume counted in the code counting step and multiplying the sum by the preset error probability per bit.

18. A motion video encoding method as claimed in claim 13, wherein in the degradation estimation calculation step, the degradation estimation in the case of the intra-frame encoding is obtained by multiplying the degradation power calculated in the degradation power calculation step by the data loss probability estimated in the data loss probability estimation step, and

the degradation estimation in the case of the inter-frame prediction encoding is obtained by obtaining the product of the degradation power and the data loss probability, obtaining a degradation propagation term as a degradation estimation of a referred area of the reference image which is referred to for a motion compensation process in the inter-frame prediction encoding, and adding the degradation propagation term to the product.

19. A motion video encoding method as claimed in claim 13, wherein in the degradation estimation calculation step, the degradation estimation in the case of the intra-frame encoding is obtained by multiplying the degradation power calculated in the degradation power calculation step by the data loss probability estimated in the data loss probability estimation step, and

the degradation estimation in the case of the inter-frame prediction encoding is obtained by obtaining the product of the

degradation power and the data loss probability, obtaining a degradation propagation term as a weighted average of degradation estimations of blocks overlapping with a referred area of the reference image which is referred to for a motion compensation process in the inter-frame prediction encoding, and adding the degradation propagation term to the product.

20. A motion video encoding method as claimed in claim 13, wherein in the degradation estimation calculation step, the degradation estimation in the case of the intra-frame encoding is obtained by multiplying the degradation power calculated in the degradation power calculation step by the data loss probability estimated in the data loss probability estimation step, and

the degradation estimation in the case of the inter-frame prediction encoding is obtained by obtaining the product of the degradation power and the data loss probability, obtaining a degradation propagation term as a degradation estimation of a referred area of the reference image which is referred to for a motion compensation process in the inter-frame prediction encoding, multiplying the degradation propagation term by a proportionality constant, and adding the multiplied degradation propagation term to the product.

21. A motion video encoding method as claimed in claim 13, wherein in the mode selection step, the degradation estimation of the target block in each candidate encoding mode is obtained from the degradation estimation calculation step, the frame coding distortion in each candidate encoding mode is obtained from the frame coding distortion estimation step, and a candidate encoding mode that minimizes the sum of the degradation estimation and the frame coding distortion is selected as the optimum encoding mode for the target block.

22. A motion video encoding method as claimed in claim 13, wherein:

the motion video encoding method further comprises a block coding distortion estimation step for estimating block coding distortion as image distortion caused by the block encoding process for the target block by referring to the input image and the reference image stored in the frame memory and the quantization step calculated in the code volume control step, and

in the mode selection step, an optimum encoding mode for the target block is selected from the intra-frame encoding, the inter-frame prediction encoding and another encoding mode "skip" in which pixel values are directly copied from a block of the reference image at the same position as the target block, by referring to the degradation estimation calculated in the degradation estimation calculation step, the frame coding distortion estimated in the frame coding distortion estimation step and the block coding distortion estimated in the block coding distortion estimation step, and

in the degradation estimation calculation step, the degradation estimation is calculated as an expected value of image degradation occurring to the target block due to data loss caused by transmission error, for each block and for each of the selectable encoding modes: the intra-frame encoding; the inter-frame prediction encoding; and the skip, based on the degradation power calculated in the degradation power calculation step and the data loss probability estimated in the data loss probability estimation step.

23. A motion video encoding method as claimed in claim 22, wherein:

in the block coding distortion estimation step, the block coding

distortion of the target block in the case of the intra-frame encoding or the inter-frame prediction encoding is estimated as quantization distortion by use of the quantization step calculated in the code volume control step, and the block coding distortion of the target block in the case of the skip is estimated by obtaining error power between the target block and a block of the reference image at the same position as the target block and regarding the error power as the block coding distortion, and

in the data loss probability estimation step, the data loss probability of the target block in the case of the intra-frame encoding or the inter-frame prediction encoding is estimated based on the code volume predicted value assigned to the target block, the code volume counted in the code counting step, and a preset error probability per bit, and the data loss probability of the target block in the case of the skip is estimated based on the code volume of a skip code which indicates that the encoding mode is the skip, the code volume counted in the code counting step, and a preset error probability per bit, and

in the degradation estimation calculation step, the degradation estimation of the target block in the case of the skip is calculated in the same way as the case of the inter-frame prediction encoding.

24. A motion video encoding method as claimed in claim 22, wherein in the mode selection step, the degradation estimation of the target block in each of the intra-frame encoding and the inter-frame prediction encoding is obtained from the degradation estimation calculation step,

the frame coding distortion in each of the intra-frame encoding and the inter-frame prediction encoding is obtained from the frame coding distortion estimation step,

an encoding mode that minimizes the sum of the degradation

estimation and the frame coding distortion is selected from the intra-frame encoding and the inter-frame prediction encoding as a candidate optimum encoding mode for the target block,

the selected candidate optimum encoding mode is compared with the skip by making a comparison between the two encoding modes with regard to the sum of the degradation estimation calculated in the degradation estimation calculation step and the block coding distortion estimated in the block coding distortion estimation step, and

one of the two encoding modes that minimizes the sum is selected as the optimum encoding mode for the target block.

25. A machine-readable record medium storing a program for instructing a microprocessor unit etc. to execute a motion video encoding method which adaptively selects and uses intra-frame encoding or inter-frame prediction encoding for encoding each block as an encoding unit, wherein the motion video encoding method comprises the steps of:

an image storage step for storing an input image and a reference image as the result of decoding of a frame before in a frame memory;

a block encoding step for referring to the input image stored in the frame memory and carrying out a block encoding process for each block of the input image according to a selected encoding mode and a quantization step designating the width of quantization of image data and thereby generating coded data;

a code counting step for monitoring the coded data and thereby counting the code volume from the latest synchronization code pattern inserted in the coded data to coded data of a block that has been encoded latest;

a code volume control step for referring to the code volume of the coded data generated in the block encoding step and a pixel value distribution statistic obtained by analyzing the input image and the

reference image stored in the frame memory, thereby calculating the quantization step for each block and for each selectable encoding mode so that image distortion caused by the block encoding process will be minimum, and outputting a code volume predicted value assigned to a target block which will be encoded next, under the condition that the code volume for a frame should be a preset volume or less;

a data loss probability estimation step for estimating the probability that data loss will occur to the target block due to transmission error, based on the code volume predicted value assigned to the target block, the code volume counted in the code counting step, and a preset error probability per bit;

a frame coding distortion estimation step for estimating frame coding distortion as image distortion caused by the block encoding processes for the frame, by referring to the pixel value distribution statistic of the input image obtained in the code volume control step;

a degradation power calculation step for calculating degradation power as error power between the input image and a decoded image assuming that data loss occurred to the target block during data transmission of the coded data, by use of the input image or the reference image stored in the frame memory;

a degradation estimation calculation step for calculating a degradation estimation as an expected value of image degradation occurring to the target block due to data loss caused by transmission error, for each block and for each selectable encoding mode, based on the degradation power calculated in the degradation power calculation step and the data loss probability estimated in the data loss probability estimation step; and

a mode selection step for selecting an optimum encoding mode for the target block by referring to the degradation estimation calculated in the degradation estimation calculation step and the frame coding

distortion estimated in the frame coding distortion estimation step.

26. A machine-readable record medium as claimed in claim 25, wherein in the degradation power calculation step, pixel values of the target block are complemented with pixel values of surrounding pixels of the input image, and error power between the complemented image and the input image is regarded as the degradation power.

27. A machine-readable record medium as claimed in claim 25, wherein in the degradation power calculation step, pixel values of the target block are complemented with pixel values of a block of the reference image at the same position as the target block, and error power between the complemented image and the input image is regarded as the degradation power.

28. A machine-readable record medium as claimed in claim 25, wherein in the degradation power calculation step, pixel values of the target block are complemented by copying pixel values from a motion compensation area of the reference image corresponding to the target block, and error power between the complemented image and the input image is regarded as the degradation power.

29. A machine-readable record medium as claimed in claim 25, wherein in the data loss probability estimation step, the probability that data loss will occur to the target block due to transmission error is estimated by adding the code volume predicted value assigned to the target block in the code volume control step to the code volume counted in the code counting step and multiplying the sum by the preset error probability per bit.

30. A machine-readable record medium as claimed in claim 25, wherein in the degradation estimation calculation step, the degradation estimation in the case of the intra-frame encoding is obtained by multiplying the degradation power calculated in the degradation power calculation step by the data loss probability estimated in the data loss probability estimation step, and

the degradation estimation in the case of the inter-frame prediction encoding is obtained by obtaining the product of the degradation power and the data loss probability, obtaining a degradation propagation term as a degradation estimation of a referred area of the reference image which is referred to for a motion compensation process in the inter-frame prediction encoding, and adding the degradation propagation term to the product.

31. A machine-readable record medium as claimed in claim 25, wherein in the degradation estimation calculation step, the degradation estimation in the case of the intra-frame encoding is obtained by multiplying the degradation power calculated in the degradation power calculation step by the data loss probability estimated in the data loss probability estimation step, and

the degradation estimation in the case of the inter-frame prediction encoding is obtained by obtaining the product of the degradation power and the data loss probability, obtaining a degradation propagation term as a weighted average of degradation estimations of blocks overlapping with a referred area of the reference image which is referred to for a motion compensation process in the inter-frame prediction encoding, and adding the degradation propagation term to the product.

32. A machine-readable record medium as claimed in claim 25,

wherein in the degradation estimation calculation step, the degradation estimation in the case of the intra-frame encoding is obtained by multiplying the degradation power calculated in the degradation power calculation step by the data loss probability estimated in the data loss probability estimation step, and

the degradation estimation in the case of the inter-frame prediction encoding is obtained by obtaining the product of the degradation power and the data loss probability, obtaining a degradation propagation term as a degradation estimation of a referred area of the reference image which is referred to for a motion compensation process in the inter-frame prediction encoding, multiplying the degradation propagation term by a proportionality constant, and adding the multiplied degradation propagation term to the product.

33. A machine-readable record medium as claimed in claim 25, wherein in the mode selection step, the degradation estimation of the target block in each candidate encoding mode is obtained from the degradation estimation calculation step, the frame coding distortion in each candidate encoding mode is obtained from the frame coding distortion estimation step, and a candidate encoding mode that minimizes the sum of the degradation estimation and the frame coding distortion is selected as the optimum encoding mode for the target block.

34. A machine-readable record medium as claimed in claim 25, wherein:

the motion video encoding method further comprises a block coding distortion estimation step for estimating block coding distortion as image distortion caused by the block encoding process for the target block by referring to the input image and the reference image stored in the frame memory and the quantization step calculated in the code

volume control step, and

in the mode selection step, an optimum encoding mode for the target block is selected from the intra-frame encoding, the inter-frame prediction encoding and another encoding mode "skip" in which pixel values are directly copied from a block of the reference image at the same position as the target block, by referring to the degradation estimation calculated in the degradation estimation calculation step, the frame coding distortion estimated in the frame coding distortion estimation step and the block coding distortion estimated in the block coding distortion estimation step, and

in the degradation estimation calculation step, the degradation estimation is calculated as an expected value of image degradation occurring to the target block due to data loss caused by transmission error, for each block and for each of the selectable encoding modes: the intra-frame encoding; the inter-frame prediction encoding; and the skip, based on the degradation power calculated in the degradation power calculation step and the data loss probability estimated in the data loss probability estimation step.

35. A machine-readable record medium as claimed in claim 34, wherein:

in the block coding distortion estimation step, the block coding distortion of the target block in the case of the intra-frame encoding or the inter-frame prediction encoding is estimated as quantization distortion by use of the quantization step calculated in the code volume control step, and the block coding distortion of the target block in the case of the skip is estimated by obtaining error power between the target block and a block of the reference image at the same position as the target block and regarding the error power as the block coding distortion, and

in the data loss probability estimation step, the data loss probability of the target block in the case of the intra-frame encoding or the inter-frame prediction encoding is estimated based on the code volume predicted value assigned to the target block, the code volume counted in the code counting step, and a preset error probability per bit, and the data loss probability of the target block in the case of the skip is estimated based on the code volume of a skip code which indicates that the encoding mode is the skip, the code volume counted in the code counting step, and a preset error probability per bit, and

in the degradation estimation calculation step, the degradation estimation of the target block in the case of the skip is calculated in the same way as the case of the inter-frame prediction encoding.

36. A machine-readable record medium as claimed in claim 34, wherein in the mode selection step, the degradation estimation of the target block in each of the intra-frame encoding and the inter-frame prediction encoding is obtained from the degradation estimation calculation step,

the frame coding distortion in each of the intra-frame encoding and the inter-frame prediction encoding is obtained from the frame coding distortion estimation step,

an encoding mode that minimizes the sum of the degradation estimation and the frame coding distortion is selected from the intra-frame encoding and the inter-frame prediction encoding as a candidate optimum encoding mode for the target block,

the selected candidate optimum encoding mode is compared with the skip by making a comparison between the two encoding modes with regard to the sum of the degradation estimation calculated in the degradation estimation calculation step and the block coding distortion estimated in the block coding distortion estimation step, and

one of the two encoding modes that minimizes the sum is selected as the optimum encoding mode for the target block.